DISTRICT OF COLUMBIA
PUBLIC SCHOOLS
Office of the Chief Academic Officer

Summer 2010

Science

Summer Learning Packet

Grades 9-12

Introduction

The activities in this packet have been adapted from Miami-Dade County Public Schools and are aligned to DCPS Standards. These activities were selected in order for students to experience science in a fun and engaging way. As you work to complete these activities this summer, you will realize that science is not only limited to the classroom. In fact, science is in our everyday lives. Science can be done away from school and can explain many of the natural phenomena that occur around us.

Biology/Environmental Science

Germinating Seeds – Let's Observe!
(Adapted from http://biology.arizona.edu/sciconn/lessons2/Roxane/teach_sec.htm)

Objectives:
This lesson is designed to teach you a few germination techniques that you may use in a future experiment. This is a simple lab intended to give you an opportunity to observe seed germination day to day.

At the end of this study, you should be able to:
- Germinate bean seeds on your own
- Observe daily change in seed germination and plant growth
- Write and draw detailed observations of changes and differences in types of seeds

Background Information:
Inside a Seed
(from: http://www.teachersdomain.org/resources/tdc02/sci/life/stru/insideseed/index.html)

Each part of a seed serves an important function. Figure 1 illustrates and identifies the five most important parts of a seed: the seed coat, the endosperm, and the embryo's primary root, cotyledon, and embryonic leaves.

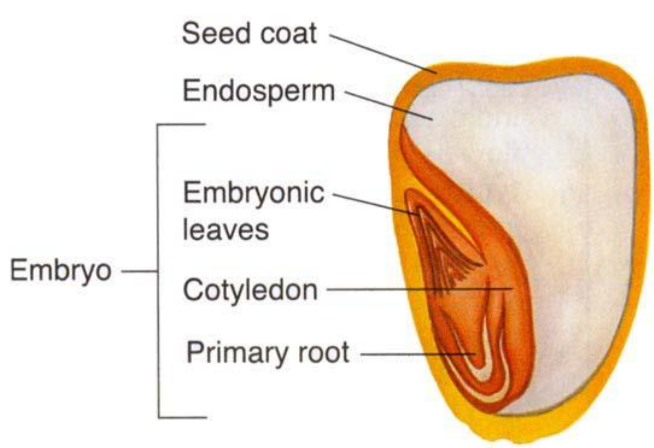

Figure 1: Parts of a seed

A **seed** is to a plant what an embryo is to an animal: an organism in its earliest stages of development. As lifeless as seeds may look before germination, the potential they hold is clear. Simply pick up an acorn and gaze at the oak tree from which it has fallen, and you can see the potential for yourself. A seed consists of three main parts: the **seed coat**, the **endosperm**, and the **embryo**. Of these parts, the embryo is the most important. Its cells will differentiate and develop into all the different tissues that will ultimately make up the mature plant. The other parts of the seed play merely supporting roles.

These roles, nonetheless, are critical to the embryo's success. The seed coat protects the internal parts of the seed during a period called dormancy, prior to germination. **Dormancy** is a protected state during which a seed "waits" for favorable growing conditions. Indeed, the seed coats of some seeds allow them to wait a very long time. The oldest known viable seeds were from an East Indian lotus. They were 466 years old when they germinated.

Germination usually begins when the embryo is exposed to water. The water swells the embryo inside, bursting the seed coat and setting growth into motion. During the earliest phase of growth, when the embryo has no leaves and therefore no means of photosynthesis, the endosperm serves as a food source. It serves the same function as the yolk in a bird egg, providing high-energy food to the developing embryo.

The embryo of a seed has three main parts: the **primary root**, the **cotyledon**(s) (there are two in many kinds of plants), and the **embryonic leaves**. The primary root, or radicle, is the first structure to emerge from the seed during germination. It penetrates the soil very rapidly, forming a slender, usually unbranched taproot, which, in some plants, may penetrate several feet into the soil during the first few weeks of growth. During this period, the cotyledon serves a function similar to that of the endosperm, supplying food to other parts of the developing embryo. Not surprisingly, the embryonic leaves, also known as seed leaves, develop into the plant's first leaves above ground. These leaves open within a few days after the plant emerges from the soil and begin photosynthesizing almost immediately to provide the growing seedling with its new - and renewable - food source.

Materials:

- kidney seeds (from the grocery store)
- lima bean seeds (from the grocery store)
- any other seed you would like
- large empty pickle jar
- pie pan
- paper towels
- wad of newspaper
- water
- glass-marking pen
- stick-on labels

Procedure:

1. Formulate a Hypothesis: (Ask yourself: What will happen to dry, hard beans when they are put on a moist paper towel? How do you know?)
2. Choose between Method 1 or Method 2 and follow the steps.

Method 1:

1. Wet two paper towels. Then line the inside walls of a large pickle jar with the towels. They should stick to the glass.
2. Fill the core of the pickle jar with a crumpled sheet of newspaper. The newspaper will hold the wet towels in place.
3. Pour water into the bottom of the glass until it is about 2-3 cm deep.

4. Now "plant" the seeds between the glass wall of the pickle jar and the wet paper towels. Place several different kinds of seeds, in different directions (sideways, upside-down, etc.).
5. Use a glass-marking pen on the jar to number where your seeds are located in the jar.
6. Draw your set-up in your journal and record what you have done by describing the seeds used and where and how they were placed in the tray or beaker.
7. Measure and record any changes observed. (go to step 8 in Method 2)

Method 2:

1. Cover the bottoms of a pie pan with 2 or 3 layers of paper towels or a combination of towels and newspapers.
2. Dampen the paper towels but do not soak!
3. Place seeds in separate regions of the pan, on top of the paper and in different orientations.
4. Cover the pie pan with plastic wrap.
5. Apply stick-on labels to the plastic so you will be able to identify the seeds.
6. Draw your set-up in your journal and record what you have done by describing the seeds used and where and how they were placed in the tray or beaker.
7. Measure and record any changes observed. (go to step 8) (NOTE: Maintain the moisture in the germinating containers to maintain your seeds as long as possible.)
8. After at least seven days of germination, split open the seed and look for the parts of the embryonic seed as shown in Figure 1.
9. Draw a picture of your own seed embryos and label the parts.

Seed Germination and Variables:

Can you think what the variables in this experiment are? Write them down in your journal.

Let's add another variable to our study. This time, prepare two containers, and germinate new seeds as you did above, but place one container near a window and another container inside a pantry or closet (without light). Record your observations as above over a seven-day period.

Questions:

1. Can a seed germinate in soil if it is placed upside down? Why do you think so?
2. Is water essential for germination? How much is too much or too little?
3. Can bean seeds (embryos) grow without their cotyledons?
4. Can another food source take the place of the cotyledons?

If you have time, germinate additional seeds, but change a variable to answer one of the following questions:

1. Does the depth at which seeds are planted have any effect on their germination? Is soil necessary for seed germination?
2. If you put seeds in the dark, with water, will they germinate? Is light essential for germination?
3. Do seeds need air to germinate?
4. Is the seed coat necessary for germination?
5. If you place seeds in a refrigerator will they germinate? In the freezer?
6. How does temperature affect germination? If we used hot water, would the seeds germinate?
7. Does the type of soil in which the seed is planted affect seed germination?

Chemistry/Physics

Making Ice Cream

Vocabulary:

- **phase change:** a change from one state of matter (solid or liquid or gas) to another without a change in chemical composition
- **physical change:** any change not involving a change in the substance's chemical identity; a phase change is an example of a physical change
- **solution:** a mixture of two or more substances that is homogenous (every sample you take is the same)
- **solute:** the dissolved matter in a solution
- **solvent:** a substance (usually liquid) capable of dissolving other substances

Background Information:
In order to have a **phase change** in matter, heat must be either gained or lost. Phase changes occur all around us in everyday life. For instance, ice melts when a drink is left in a room at normal temperature; conversely, water freezes when placed in a location where the temperature is at or below 0^{o}C or 32^{o}F.

In this experiment we see how heat is lost in order to change milk from a liquid state to a solid state. This is an example of a **physical change** in matter. Students will also be able to observe how adding **solute** (salt) to a **solvent** (ice/water) changes the physical properties of that solvent. In this case the freezing point of the water is lowered allowing for the milk to turn into ice cream. The materials for this lab should be relatively inexpensive and you may have many of these materials already at home.

Materials:

- 1/2 cup milk
- 1/2 cup whipping cream (heavy cream)
- 1/4 cup sugar
- 1/4 teaspoon vanilla extract or vanilla flavoring (vanillin)
- 1/2 to 3/4 cup sodium chloride (NaCl) as table salt or rock salt
- 2 cups ice
- 1-quart Ziploc™ bag
- 1-gallon Ziploc™ bag
- thermometer
- measuring cups and spoons
- dishtowel
- cups and spoons for eating your treat!

Procedures:

1. Place a dishtowel over your work area. Keep your work on the towel.
2. Pour the milk, sugar, and vanilla into the 1-quart Ziploc™ bag. CAREFULLY seal the bag and shake up the mixture thoroughly.
3. Put this 1-quart Ziploc™ bag inside the much larger 1-gallon Ziploc™ bag.

4. In the 1-gallon bag add enough ice to almost fill the bag and add the NaCl. Take the temperature of the ice:______ C
5. CAREFULLY SEAL THE BAG!
6. Put your gloves on and get ready to make a phase change!
7. Rock the bag back and forth gently, making sure the smaller Ziploc™ bag is covered by the ice/salt mixture. Remember to keep the bag over the towel at all times. It should take 10 to 15 minutes to freeze. Take the temperature of the ice/water mixture again: ________ C
8. When you have ice cream, take the smaller bag out and rinse it off with cold water. Throw out the contents of the larger bag.
9. Dish out the ice cream into the cups, and ENJOY!
10. Please clean up your area.

Student Questions

1. What state of matter was the milk when you began? What state of matter was the milk when you were done?
2. In order to change the milk to a solid, what had to be removed?
3. What happened to the energy that left the milk?
4. Why was salt added to the ice?
5. If you had left out the sugar, would the ice cream have frozen faster or more slowly? Why?
6. Assuming the bag was not leaking, why did the outside of the bag become wet?
7. Why is salt spread on icy roads in the winter?
8. What would happen if you didn't add salt to the ice?

Additional Information:

You could use other types of salt instead of NaCl, but you couldn't substitute sugar for the salt because sugar doesn't dissolve well in cold water and sugar doesn't dissolve into multiple particles like an ionic compound such as salt. **Ionic compounds** break into pieces upon dissolving, like NaCl breaks into Na^+ and Cl^-. They are better at lowering the freezing point than substances that don't separate into particles because the added particles disrupt the ability of the water to form ice. The salt causes the ice to absorb more energy from the environment (becoming colder), so although it lowers the point at which water will re-freeze into ice, you can't add salt to very cold ice and expect it to freeze your ice cream or de-ice a snowy sidewalk (water has to be present!). This is why NaCl isn't used to de-ice sidewalks in areas that are very cold.

Additional Resources:

- Online conversions, in order to convert metric system to standard or British system of measurement: http://www.onlineconversion.com/
- Pressure cookers: http://en.wikipedia.org/wiki/Pressure_cooking
- Boiling water in a vacuum: http://www.exo.net/~pauld/Mars/4snowflakes/martianwater.html
- Phases and phase changes: http://itl.chem.ufl.edu/2045_s00/lectures/lec_f.html
- Phases animation: http://www.harcourtschool.com/activity/states_of_matter/
- Physics of phase changes: http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/phase.html